NSTX edge-plasmas with a lithium coated divertor*

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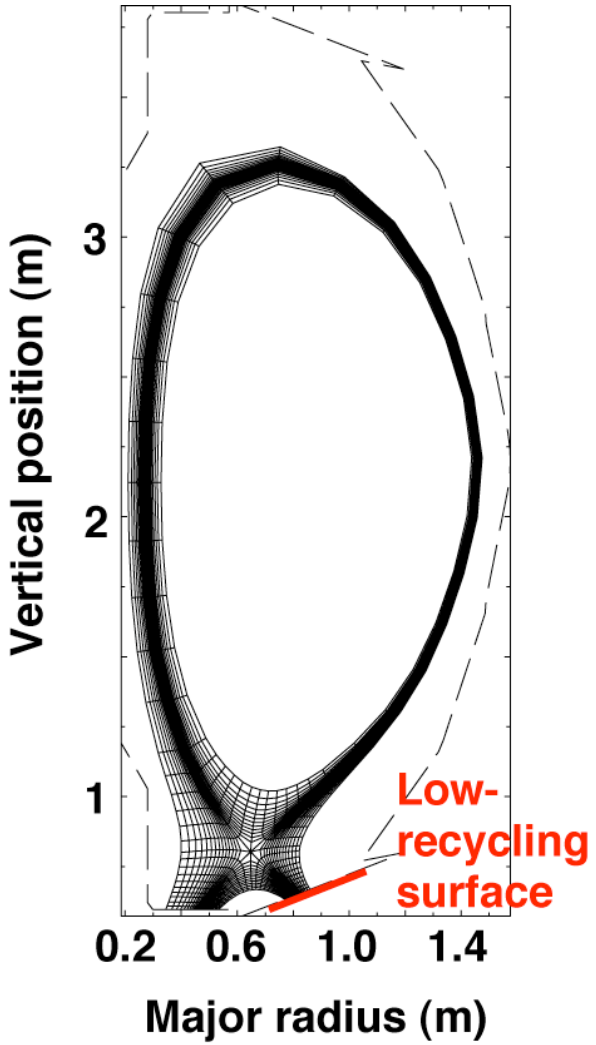
Effect of low-recycling is illustrated for an NSTX case

- **Use 2D UEDGE fluid transport with kinetic corrections**
- **Begin with a base-case with high recycling (shot 109034, Porter)**
  - P_{core} = 2 MW
  - D = 0.5 m^2/s, □ = 1.5 m^2/s
  - R = 1.0
  - Wall gas albedo = 0.95
  - Carbon impurity
- **Solutions for R = 1.0, 0.9, 0.5, and 0.2 on outer divertor only**

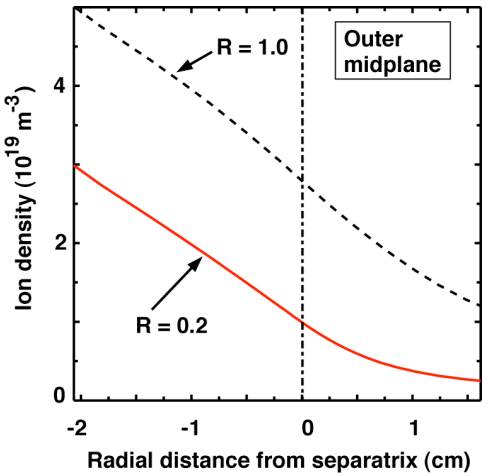


NSTX full-coverage Li modeling: Low recycling increases midplane temperatures by factor of ~2

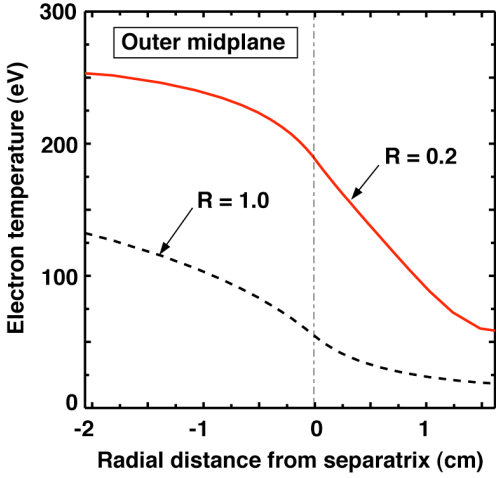
- Low recycling decreases edge density for fixed source
- For R=0.2, □ ~ $L_{||}$
- Sputtering increases for low recycling (high T_e)

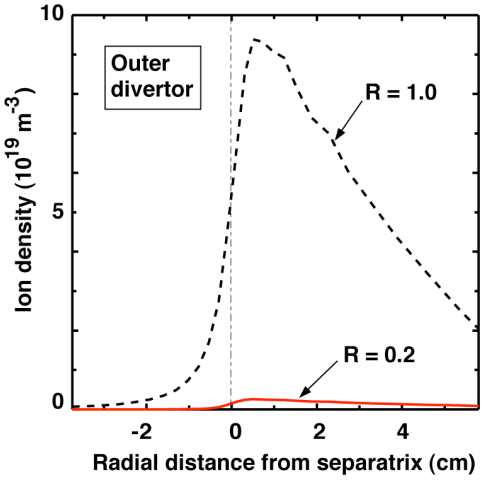
Increased edge temperature may reduce core turbulence

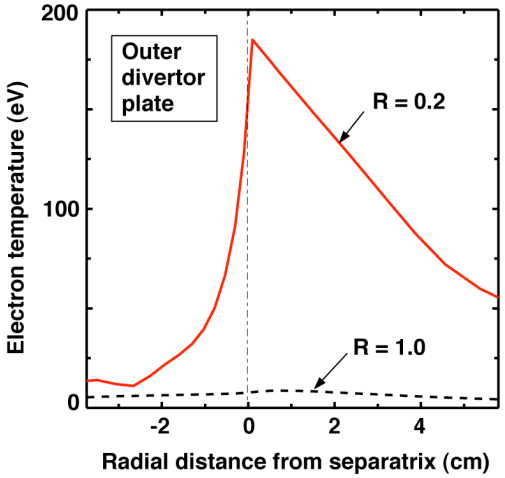
Ion density



Electron temperature

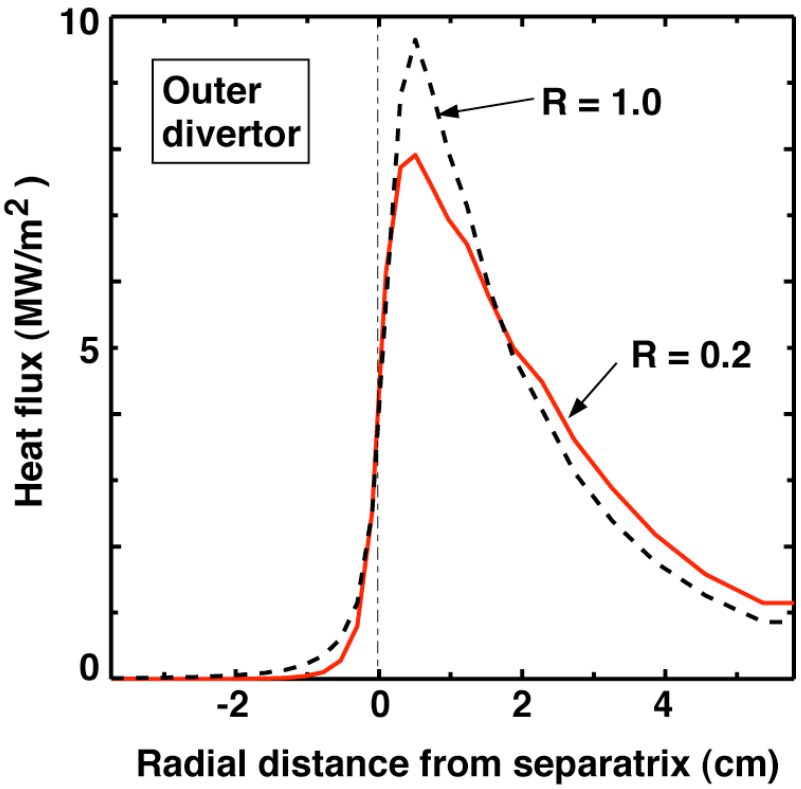






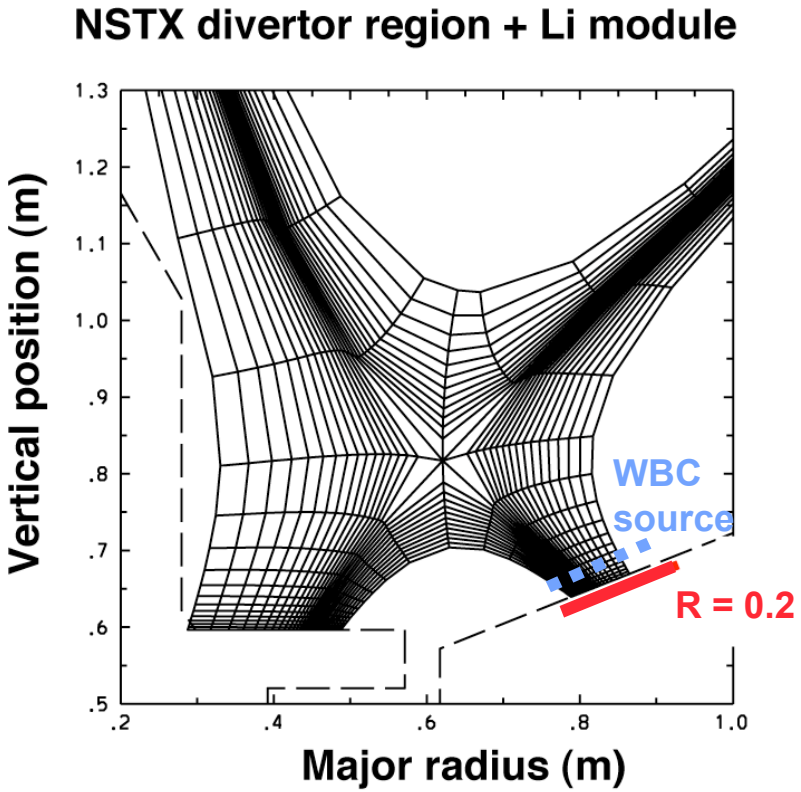
Peak divertor heat flux largely unchanged by R

- **Direct energy loss from escaping particles scales as $nT\ T^{1/2} = nT^{3/2}$ at the divertor**
- **For high collisionality, nT ~ constant along B-field**
  - implies heat flux ~ $T^{1/2}$
- **However, for low recycling, $nT|_{midplane} >> nT|_{divertor}$**



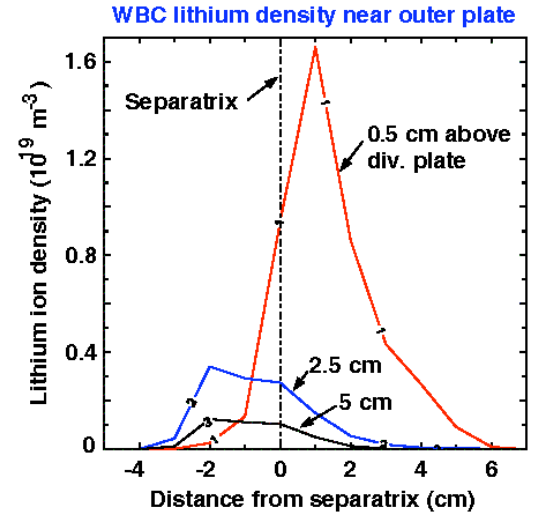
Contamination of core from lithium divertor being modeled by coupling UEDGE & WBC MC code

- Heat and particle flux to module computed by UEDGE
- Temperature rise of Li surface from heat transfer (Ulrickson)
- Sputtering of Li from U. Ill. composite model (Allain et al.)
- WBC calculates lithium source near the divertor plate (Brooks)
- UEDGE uses this Li source to calculate lithium density throughout the edge region

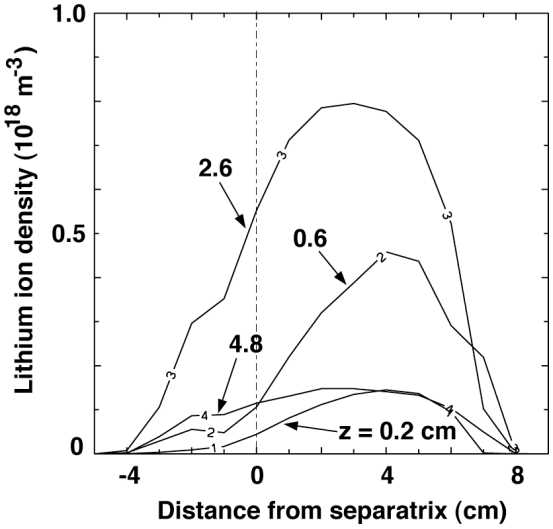


WBC Li sputtering shows lower density for low R_p (from J. Brooks)

- Smaller R_p gives lower hydrogen plate flux
- Lower electron density causes Li^+ to peak farther from plate
- Parallel ambipolar electric field $E_{||}$ pushes Li^+ back to divertor; $E_{||}$ is larger for R_p=0.2



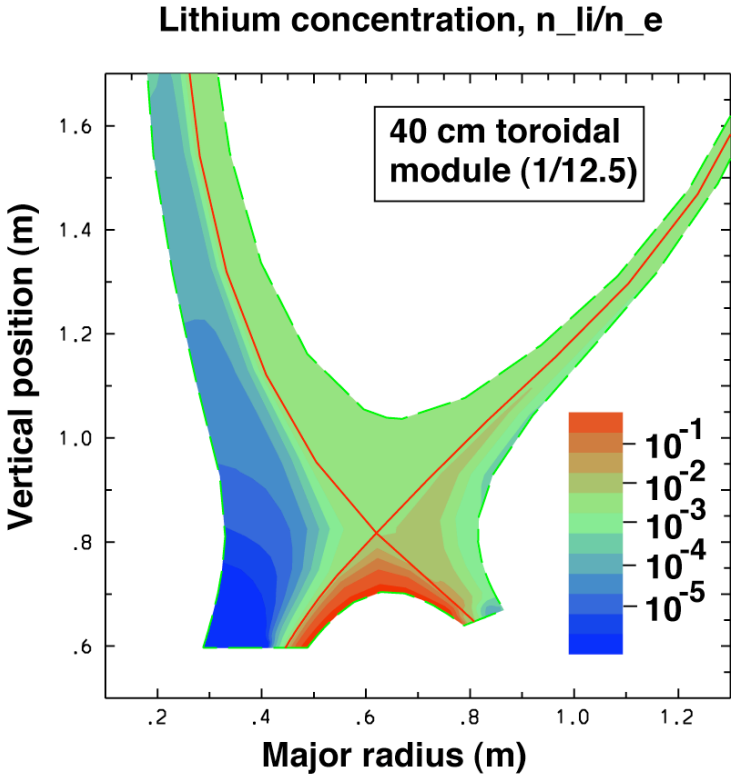
R_p=0.9



R_p=0.2

Lithium flows throughout the SOL, but core boundary concentration appears low

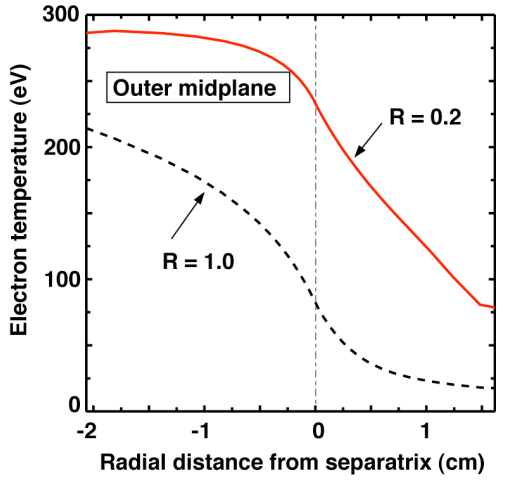
- **Lithium concentration peaks in outer SOL and private-flux regions**
- **Primary forces keeping Li in divertor are E_p & hydrogen drag**
- **Lower recycling good because**
  - Lower sputtering hydrogen flux
  - Monotonic downward E_p ; R=0.2 much better than R=0.9
  - Higher sputtering rate is bad

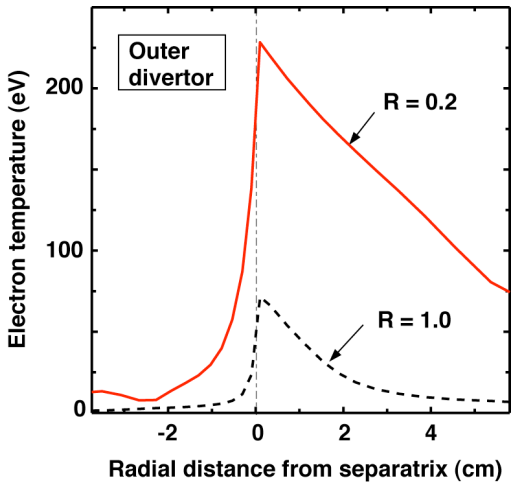


A substantial convective particle loss about the outer midplane can decrease effect of R

- Add a radial convective velocity increasing from 10 m/s --> 100 m/s from core --> wall
- Increased wall flux gives increased pumping (albedo=0.95) - model dependent
- Effectiveness of divertor pumping is decreased

Electron temperature





Summary

- **Simulating low-recycling plasmas uses known modifications to fluid transport models**
- **Substantial increase in edge temperature is calculated**
- **Plasma convection shows some reduction of core-edge T increase**
- **Lithium contamination studies for NSTX begun**
  - Impurity screening at low R aided by E_p & downward hydrogen flow
  - Role of convection on Li must be included